Create a plot within the log(ρ) vs log(T) plane of the ignition curves for H and He.

Energy Generation Rates

We do this by plotting the curves $\mathrm{q} = \mathrm{q}_{min}$, with q_{min} ~ $10^3 erg \cdot g^{-1} \cdot s^{-1}$

For H, take the energy generation as:

$$q_{pp} = \frac{2.4 \times 10^4 \rho X^2}{T_9^{2/3}} e^{\frac{-3.380}{T_9^{1/3}}} erg \cdot g^{-1} \cdot s^{-1}$$

and

$$q_{CNO} = \frac{4.4 \times 10^{25} \rho X Z}{T_9^{2/3}} e^{\frac{-15.228}{T_9^{1/3}}} erg \cdot g^{-1} \cdot s^{-1}$$

For He, use:

$$q_{3\alpha} = 5.09 \times 10^{11} \rho^2 Y^3 T_8^{-3} e^{\frac{-44.027}{T_8}} erg \cdot g^{-1} \cdot s^{-1}$$

Where $\mathrm{T}_8 \equiv T/(10^8 K)$ and $\mathrm{T}_9 \equiv T/(10^9 K)$

We will also place a point in our plot to indicate where the Sun's core is.

We need a function that returns ρ for a given T for H burning. For both the pp-chain and the CNO cycle, we can use the form:

$$q = \rho A(T)$$

so we can get $\rho(\mathrm{T})$ using $\mathrm{q} = \mathrm{q}_{min}$ as:

$$\rho = \frac{q_{min}}{A(T)}$$

For He burning, now we have:

$$q = \rho^2 A(T)$$

so we can get $\rho(\mathrm{T})$ using $\mathrm{q} = \mathrm{q}_{min}$ as:

$$\rho = \sqrt{\frac{q_{min}}{A(T)}}$$